POTENTIAL RISK TO RING-NECKED PHEASANTS FROM APPLICATION OF TOXIC BAIT FOR BLACKBIRD CONTROL IN SOUTH DAKOTA

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Abstract: Blackbird (Icterinae) damage to sunflowers in the northern Great Plains can be locally severe. One approach to alleviating depredation pressure is to reduce blackbird populations through application of brown rice bait treated with the avicide DRC-1339. Because such baiting can potentially affect nontarget species, we conducted pen and field trials to evaluate the potential risk from avicide baiting to ring-necked pheasants (*Phasianus colchicus*). Although most female pheasants in pen tests preferred cracked corn and sorghum, 2 of 12 birds preferred brown rice. In 4-day trials within a 0.2-ha flight pen, pheasant consumption of brown rice from bait swaths simulating field bait applications was not affected by the presence of an alternate bait swath of cracked corn. Pen trials to evaluate possible avoidance responses following a sublethal dose of DRC-1339 showed that 2 of 7 birds shifted from their previously preferred feeding sites following exposure to the avicide. During March and April 1995, we recorded pheasant numbers in 6 pairs of 0.8-ha plots in corn stubble fields that were either baited with brown rice or were designated as reference plots. Overall, use of test plots was low, but at the most heavily used sites, pheasants visited reference plots more than baited plots ($P = 0.004$). We conclude that (1) pheasants will eat brown rice treated with DRC-1339; and (2) although chances of exposure to an acute lethal dose can be reduced by increasing the dilution, harmful repeated doses could be obtained because avoidance of feeding sites, following sublethal exposure, cannot be assumed.

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Sunflower is an economically important crop in the Prairie Pothole Region of North Dakota and South Dakota, with >991,000 ha harvested in 1994 (North Dakota Agricultural Statistics Service 1995*a*, South Dakota Agricultural Statistics Service 1995). Cattail (*Typha* spp.)-dominated wetlands in this region are used by roosting blackbirds during spring and fall migration (Linz et al. 1995*b*). During the fall, blackbirds can severely damage ripening sunflower fields (Hothem et al. 1988). Although habitat modification can successfully reduce blackbird populations roosting near sunflower fields (Linz et al. 1995*b*), 82% of sunflower producers experiencing blackbird damage support avicide development to reduce blackbird populations (North Dakota Agricultural Statistics Service 1995*b*).

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The avicide DRC-1339 (3-chloro-4-methylbenzenamine HCl) is highly toxic to blackbirds and other crop-depredating species (DeCino et al. 1966) and recently has been applied as a bait to reduce wintering blackbird populations affecting rice production in the Southeast (Glahn and Wilson 1992). In North Dakota, attempts to control blackbirds by baiting with DRC-1339 in ripening sunflower fields during the fall have been unsuccessful (Cummings et al. 1990, Linz and Bergman 1996).

An alternative approach is to reduce blackbird populations by baiting them in harvested cornfields during their spring migration (Knittle et al. 1987, Linz et al. 1995*a*). There is concern, however, because nontarget species that may be affected by DRC-1339 also feed in these fields (Linz et al. 1995*a*). In particular, ring-necked pheasants frequent harvested cornfields searching for abundant waste corn, which composes 43% of their spring diet (Trautman 1982). The acute, median lethal oral dose (LD_{50}) is 2.4 mg/kg for red-winged blackbirds (*Agelaius phoeniceus*) and 10 mg/kg for pheasants (DeCino et al. 1966).

In addition to acute toxicity, there is potential for dietary exposure to DRC-1339. Repeated exposure to DRC-1339 is toxic to birds because of cumulative damage to kidney tissue and subsequent uremic poisoning (Schafer et al. 1977). It is also possible, however, that sublethal exposure to DRC-1339 could cause conditioned avoidance so that pheasants would not revisit or feed at a site where they experienced ill effects following ingestion of a sublethal dose.

The purpose of this study was to evaluate the potential hazard to pheasants posed by the DRC-1339 brown rice bait application. Our specific objectives were (1) determine bait preferences and feeding behavior of captive, pen-raised hen pheasants; (2) document behavioral effects in captive pheasants following dietary exposure to DRC-1339; and (3) monitor use of test-bait plots by free-ranging pheasants.

METHODS

Bait Preference

In January 1995, we randomly assigned 12 hen pheasants obtained from a game-bird farm near Gainesville, Florida, to individual 3.1- × 9.2- × 1.8-m outdoor test pens. We started a 4-day choice test after 24 hr of acclimation to the test pens, during which time the pheasants had free access to a commercial game-bird maintenance diet. Each bird received 4 bowls, with each bowl containing 100 g of 1 of 4 foods: brown rice, millet, whole corn, or cracked corn. Each day, we also weighed 4 bowls of food inaccessible to birds as a check for mass change caused by ambient conditions. We measured consumption from each bowl, corrected for moisture changes, replaced the bowls with fresh ones, and rotated positions of the bowls daily at 1000. After 4 days, we returned the birds to their holding pen. We maintained and tested birds according to procedures approved by the Institutional Animal Care and Use Committee of the National Wildlife Research Center. We used analysis of variance (ANOVA) to analyze consumption data in a 3-factor (day, food, bird) randomized complete block design (SAS Institute 1988). Duncan's multiple range test separated means ($P = 0.05$).

Simulated Baiting in Flight Pen

During February–March 1995, we plowed 2 20- × 25-m plots within a 0.2-ha flight pen. On 1 plot (randomly determined), we hand-broadcast a swath approximately 3.5 × 26.5 m with 250 g of brown rice to approximate the baiting density (28–30 kg/ha) proposed for blackbird control in South Dakota. Within the bait swath, we randomly located 16 sampling quadrats that were 0.19 m^2 and set the number of brown rice grains on each quadrat to 30.

We randomly selected 3 pheasants and released them into the flight pen. We provided only water, but grass and weed seeds and invertebrates within the pen were freely available. We monitored rice consumption daily by counting the grains left on the sampling quadrats. After 4 days, we removed the test birds, replaced them with 3 others, replenished the bait lane, and reset the sampling quadrats to 30 grains. We conducted 6 replications with 18 different birds.

We then repeated the procedure with 5 new sets of birds, but we used 2 bait lanes, 1 with brown rice and the other with cracked corn at the same density. The corn was sieved, and we used particles that passed 3.4-mm openings but not 2.4-mm openings. In each test group, we observed birds for varying periods of time from a blind at 1 end of the flight pen, and we recorded the amount of time individuals spent on the bait lanes and elsewhere in the pen. Removal of brown rice particles with and without the presence of the alternate corn bait was compared in a 1-way ANOVA (Minitab 1994).

DRC-1339 Aversion Test

In February and March 1996, each of 7 hen pheasants was housed in an outdoor pen (3.1 × 9.2 × 1.8 m) with water available at all times. At 1 end of each pen, a pile of cut branches provided shelter and cover. We established 2 feeding stations that were 2 m apart: 1 on the north side and 1 on the south side of each pen. A ceramic bowl set in an aluminum spillage pan held the bird's food at each feeding station. During a 3-day acclimation period, we provided a mixture of untreated brown rice and commercial game-bird starter. We then gave each bird 2 bowls of 50 g of brown rice for 3 days. We measured consumption and replenished the bowls to 50 g at 0800 daily. A bowl of food kept inaccessible to birds was also weighed daily as a check for mass change caused by ambient conditions. We calculated a preference score for each bird by dividing daily consumption from the north bowl (chosen arbitrarily) by the total daily consumption.

The afternoon before the treatment, we removed the birds' food at 1600. At 0800 the next morning, we provided each bird with 1 feeding bowl placed in the location favored by the bird (north or south) during the pretreatment period. Each bowl contained 10 g of brown rice, 5 grains of which were treated with DRC-1339 at the field use rate of 2% (g/g). If the mass of an average brown rice bait is 20 mg, then a 2% bait holds approximately 0.4 mg of DRC-1339. Five such baits represent 2.0 mg, which is one-fifth the acute median lethal dose of 10 mg for a 1-kg pheasant (DeCino et al. 1966). Therefore, a bird that ate all of the brown rice provided received one-fifth of an LD_{50} dose.

We removed the treated food bowl at 1400 and provided 2 food bowls, each with 50 g of untreated brown rice. We measured consumption and replenished food bowls to 50 g at 0800 on each of the next 3 days and calculated preference scores as before. To identify shifts in preferred feeding sites, we used a 2-factor ANOVA with test period as the fixed effect and individual as the blocking factor to compare posttreatment to pretreatment preference scores. We used Tukey's HSD test (Steel and Torrie 1980) to separate means (P = 0.05). We monitored the activity of 2 birds from a blind to document movements and behavior before and after exposure to treated bait.

Field Trial

In eastern South Dakota during March–April 1995, we established paired 0.8-ha plots 50–100 m apart in 6 fields of corn stubble. One plot within each pair was initially baited with untreated rice; the other plot was unbaited and served as a reference. Each field was within 1.2 km of a blackbird roost in a cattail marsh.

Beginning on the day of baiting, we used binoculars to scan each plot of a given pair from a stationary point. We conducted scans for 1-min during each 5-min interval within 1 hr and recorded the number and activities of pheasants for each scan. We divided daylight hours into 3 time periods of equal length, and the first 1-hr observation began within 30 min of the beginning of each time period. We did not observe if the wind exceeded 24 km/hr or if there was steady precipitation. We assumed that habitat characteristics and visibility were similar between paired plots, but we did not quantify these items.

We tested the null hypothesis that pheasant use was equal between baited and reference plots within pairs and across sites via the 2-sample sign test (Conover 1980). We compared activity on an hourly basis and assumed that pheasant activity in 1 plot did not affect pheasant use of the paired plot.

RESULTS

Bait Preference Tests with Individual Pheasants

Food consumption did not vary among birds ($F_{11,99}$ = 1.00, P = 0.448). Days had a marginal effect, as the first day's consumption was somewhat suppressed ($F_{3,99}$ = 2.64, P = 0.054). There were marked differences, however, among types of food ($F_{3,99}$ = 7.87, P = 0.0001). Pheasants (n = 12) ate cracked corn (8.6 g/bird, SE = 1.8) and sorghum (7.1 g/bird, SE = 1.7) preferentially (P < 0.05) to brown rice (3.9 g/bird, SE = 1.3) and whole corn (2.0 g/bird, SE = 0.7). Preference differed among birds ($F_{33,99}$ = 6.62, P < 0.001). For example, 7 birds ate no rice, but 2 preferred rice to the other foods. Four pheasants preferred cracked corn and sorghum, 1 preferred whole corn, and 1 displayed no clear preference.

Table 1. Observations of groups of 3 pen-raised female ring-necked pheasants on a simulated bait lane within a 0.2-ha flight pen during 6 separate 4-day trials.

Group	Bird-minutes[a] Total	Bird-minutes[a] On bait lane	Brown rice grains removed from sampling quadrats[b]
A	2,880	15	38
B	1,440	8	168
C	2,160	104	272
D	360	1	160
E	270	0	4
F	240	27	367

[a] Bird-minutes equals the number of birds × number of minutes observed.

[b] 16 sampling quadrats with an initial count of 30 grains each.

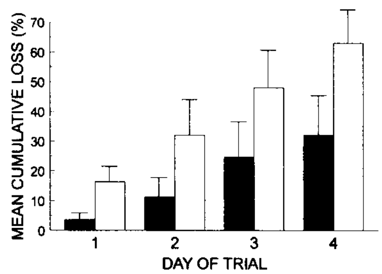

Fig. 2. Cumulative removal of brown rice (shaded bars) and corn (open bars) particles by 5 groups of 3 hen pheasants during 4-day trials in a 0.2-ha flight pen. Each sampling quadrat initially held 30 particles. Vertical bars indicate 1 standard error.

Flight-Pen Trials of Simulated Bait Application

Brown Rice Only.—Total number of brown rice baits removed during 4-day trials varied from 4 to 367 (Table 1). Overall, bait removal averaged 168 (SE = 56, n = 6), or 35% (Fig. 1). We recorded bait loss on day 1 for only 1 group. Two groups did not remove baits from sampling quadrats until day 3. Observations of birds in the flight pen revealed that pheasants generally fed in the bait lane briefly and then moved to other parts of the flight pen. Individuals spent up to 11 min in the bait lane, but foraging was not centered on the bait lane, even after birds discovered it.

Alternate Bait Lane Provided.—Bait removal was extremely variable among groups and ranged from 0 to 79% in rice and from 30 to 98% in corn (Fig. 2). Four of the 5 test groups removed more corn than rice, and 1 removed no rice although we observed birds on the bait lane (Table 2). Pheasants fed on the bait lanes approximately 2% of the time. Individuals spent up to 4 min in the rice bait lane, but we were unable to count reliably the number of bait grains eaten by individuals. Removal of brown rice was not affected ($F_{1,9}$ = 0.03, P = 0.866) by the presence of the alternate bait lane.

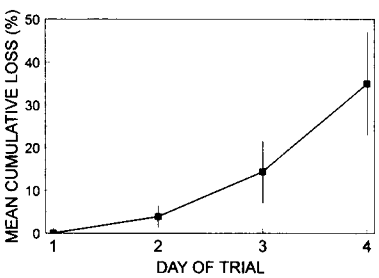

Fig. 1. Cumulative removal of brown rice grains by 6 3-bird groups of hen pheasants from sampling quadrats on a simulated bait lane within a 0.2-ha flight pen. Vertical bars indicate 1 standard error.

DRC-1339 Aversion Test

Food consumption among test birds (n = 7) did not vary across days ($F_{3,24}$ = 1.46, P = 0.250) and averaged 48.3 g (SE = 5.4) on the day prior to treatment, and 56.4 g (SE = 8.5), 41.9 (SE = 5.5), and 39.2 g (SE = 5.2) on 3 posttreatment days. During pretreatment, 3 birds exhibited strong side preferences ($F_{6,28}$ = 14.14, P < 0.001); the preferences of the others were less emphatic (Fig. 3). Each bird ate all the treated bait offered. Following treatment, 2 birds showed substantial shifts in preference of feeding site (P < 0.05), while 5 birds continued to eat from the treated side of their pen with the same frequency as during pretreatment (Fig. 3).

The 2 birds we observed each had strong preferences for the north side that did not change after exposure to DRC-1339. Behavioral

Table 2. Observed use of simulated bait lanes and numbers of particles removed from sampling quadrats on the bait lanes by 3-bird groups of hen pheasants during 4-day feeding trials in a 0.2-ha flight pen.

Group	Bird-minutes[a] Total	Bird-minutes[a] In rice	Bird-minutes[a] In corn	Particles removed from sampling quadrats[b] Rice	Particles removed from sampling quadrats[b] Corn
G	585	6	3	377	146
H	360	0	3	118	164
I	720	13	5	181	265
J	540	5	15	0	469
K	600	1	3	91	472

[a] Bird-minutes equals the number of birds × the number of minutes observed.

[b] There were 16 sampling quadrats in each bait lane; each quadrat initially held 30 particles, for a total of 480.

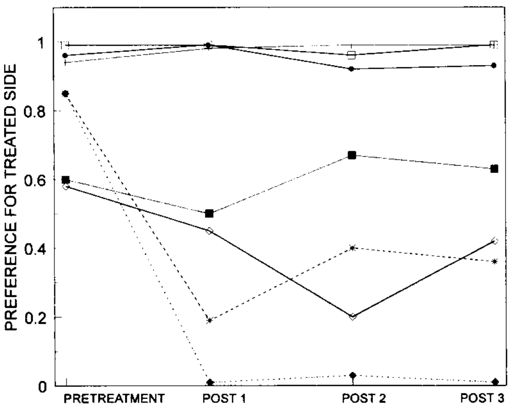

Fig. 3. Feeding preference scores (consumption from preferred side of pen divided by total consumption) of individual hen pheasants during pretreatment and on 3 days following exposure to brown rice treated with DRC-1339. The treated bait was placed at the feeding site preferred during pretreatment.

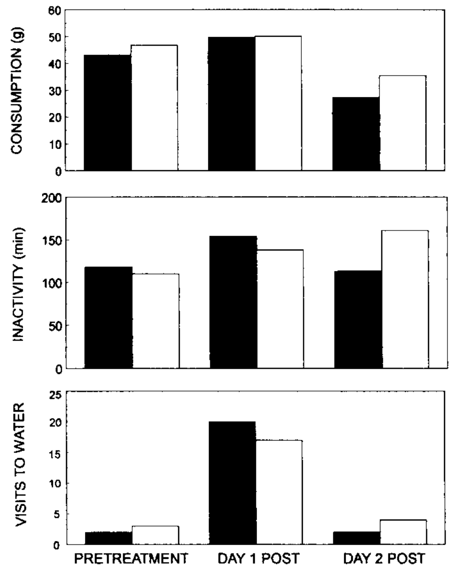

Fig. 4. Behavior of pheasant number 5 (solid bars) and number 7 (open bars) 24 hr before and 2 days after exposure to DRC-1339.

changes in these birds, however, were consistent with consumption of treated bait. Drinking increased dramatically during the 24 hr after treatment (Fig. 4). Also, each bird was less active following treatment than during the preceding 24 hr, and food consumption declined somewhat.

Field Test

We recorded 61 instances of pheasant use of plots during 1,632 min of observation (Table 3). Because observations were performed over 12 consecutive 5-min periods, some pheasants were observed repeatedly in a given hour. After removing these repeats, we estimated that at least 25 different birds used the plots.

We observed more pheasants in the reference plot at the Ramona R1 site than in the baited plot ($S = 4$, $P = 0.062$). When both sets of plots at Ramona were combined, reference plots had higher numbers of birds than did baited plots ($S = 9$, $P = 0.004$). Except for the Arlington A1 site where use of the plots was equal, there were insufficient pheasant observations for statistical comparisons at other locations.

It was possible to follow some birds over several 5-min time periods because pheasants visited the plots in groups of ≤ 3. These observations revealed that birds remained in the plots for short amounts of time ($\bar{x} = 8.2$ min in reference plots, 18.4 min in baited plots). The longest observation of a single bird was 30 min. Generally, the birds covered a large area rather quickly and stopped only occasionally among the rows of corn stubble to peck at the ground or look around. This behavior is consistent with the flight-pen observations, which revealed that pheasants moved frequently and with only brief stops to feed in the bait lanes.

DISCUSSION

In the field, the risk of DRC-1339 brown rice bait to pheasants will be a function of how often they feed on a bait lane and how long they feed there during each visit. Because the acute, median lethal dose of DRC-1339 to pheasants is 10 mg/kg, the LD_{50} for a 1-kg pheasant is 10 mg. At a 2% treatment rate, a 20-mg grain of brown rice contains 0.4 mg of DRC-1339. Therefore, to obtain an acute lethal dose of 10

Table 3. Ring-necked pheasant use of 6 0.8-ha study plots in fields of corn stubble in eastern South Dakota, March–April 1995. Baited plots received brown rice baits; reference plots did not.

Roost	Site	Hours observed	Pheasants observed Reference	Baited
Ramona	R1	17	18	6
	R2	15	12	0
Arlington	A1	11	9	9
	A2	8	0	6
Bryant	B1	8	0	1
	B2	9	0	0
Totals	(6 sites)	68	39	22

mg, a pheasant must eat 25 grains of treated rice. Current practices call for treated baits to be diluted 24:1 with untreated brown rice (L. E. Huffman, U.S. Department of Agriculture personal communication). Thus, 25 treated baits represent 625 total baits (12.5 g). A rapidly feeding bird (1 bait/sec) would require about 10 min to eat that much brown rice. We do not know the feasibility of such a rapid feeding rate, but 10 min approaches the maximum time we observed pheasants on the brown rice bait in the flight pen, and field results confirmed that a 10-min visit to a bait site is likely.

Even if birds do not acquire a lethal dose during a single feeding bout, repeated exposure to nonlethal doses could be a concern. Schafer et al. (1977) exposed 4 pheasants to corn treated with 2% DRC-1339 diluted 69:1 with untreated corn. The 4 birds on this regime died within 16–22 days and consumed a mean daily DRC-1339 dose of 5.9 mg/kg, or 0.6 LD_{50}. To receive the same daily exposure, pheasants must eat 15 treated baits, or 375 total baits if the dilution is 24:1. Such a level of daily consumption of brown rice is certainly reasonable, particularly if birds revisit a bait site throughout the day. Kidney tissue damage and uremia from DRC-1339 are cumulative (Schafer et al. 1977), and so it appears possible that pheasants could acquire lethal doses over a 2–3-week baiting period.

Five birds, including the 2 we watched, did not avoid their preferred feeding site after exposure to sublethal amounts of DRC-1339. The birds we observed each exhibited patterns of behavior consistent with DRC-1339 exposure, however, particularly increased drinking activity (DeCino et al. 1996). Thus, treated bait was not avoided; it was consumed but was not a sufficiently strong stimulus to produce an avoidance response in every bird.

MANAGEMENT IMPLICATIONS

If operational baiting with DRC-1339 is seriously contemplated for the Northern Great Plains, then the need for additional field study of nontarget hazards is clear. If pheasants in our study had not eaten brown rice baits, or if they had developed consistent avoidance responses to a sublethal dose of DRC-1339, then this need might not be as great. Pheasants exhibited neither of these behaviors; hence, the possibility persists that blackbird baiting activity will cause pheasant mortality. Future field research should include telemetry to define patterns of bait-site use by individual pheasants and to document clearly the effects to exposed individuals and populations. Further evaluation of spring baiting for managing blackbird damage to the sunflower crop is also needed because reducing populations of blackbirds in the spring may not reduce crop damage in late summer. Analysis through modeling may be useful to estimate the extent of population reduction necessary to achieve desired levels of damage reduction.

Nontarget hazard can be immediately reduced by increasing the untreated:treated bait dilution to 49:1 or 99:1. The brown rice baits are formulated to deliver a lethal dose of DRC-1339 to a blackbird with a single bait. Pen studies have demonstrated that higher dilutions can be efficacious (Glahn et al. 1988), and additional field research on bait dilutions would be welcome. Other possible measures to reduce nontarget hazards are to place bait only in plots fenced to exclude pheasants and to establish bait sites only in areas with minimal cover (i.e., old soybean fields).

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